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DEPARTMENT OF ECOLOGY

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M E M O R A N D U M

May 18, 1984

To: Tom Eaton, Southwest Regional Office
From: Dale Clark, ^{DC}Water Quality Investigations Section
Subject: Gig Harbor Class II Inspection

INTRODUCTION

On July 18 and 19, 1983, a Class II inspection was carried out by the Washington State Department of Ecology (WDOE) at the Gig Harbor Wastewater Treatment Plant (WTP), as you requested. The main purpose of the survey was to determine if the WTP was complying with current effluent discharge limitations as designated in the plant's National Pollution Discharge Elimination System (NPDES) permit (Permit No. WA-0022395-7). Other priorities of the inspection were to compare WTP and WDOE laboratory analytical results, review laboratory procedures, and determine whether the WTP is becoming hydraulically and/or organically overloaded.

Participants in the WTP inspection were Bill Yake and Dale Clark, WDOE water quality investigators; Darrel Anderson (SWRO) WDOE water quality inspector; Jim Landon, WTP supervisor; Bill Irely, WTP operator; and Gary Tannahill, Gig Harbor city engineer.

In conjunction with the source inspection, a receiving water study was carried out by WDOE investigators, the results of which are published in a separate report (Singleton and Bailey, 1983).

SETTING

Gig Harbor is a small community located on the Kitsap Peninsula, and borders an estuary of the same name (Figure 1). The community is served by a treatment facility (Figure 2) that discharges into the upper end of the estuary, as shown on Figure 3.

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The Gig Harbor WTP was initially designed to serve a population of 3,500 at a design flow of 0.45 million gallons per day (MGD). The existing secondary plant started operating on March 10, 1973 (Table 1, Figure 2)

Wastewater is pumped to the WTP where it enters the headworks and flows through a rotating screening unit for grit removal. The influent then flows into a small aerated chamber (formerly for grit removal) and into a comminutor and splitter box for routing to the two parallel activated sludge reactors. These aeration basins are operated as a conventional, complete-mix, activated sludge system. At design flow, wastewater is detained in the reactors for approximately four hours. From the reactors, wastewater flows to two parallel secondary clarifiers. The secondary clarifiers are rim-feed, center-discharge type. The return activated sludge (RAS) is pumped back to the reactors or wasted, as necessary. After clarification, the wastewater flows into two parallel chlorine contact chambers for disinfection and discharge.

Plant flow is measured prior to the chlorination chambers by an in-line flow meter and totalizer. A remote script chart recorder is used to record flow (Figure 4). As can be seen by the script chart, in addition to typical diel flow cycles, substantial flow surges occur (wide band on chart) due to the activity of the sewage pump stations. The flow measurements are biased to the high side because final effluent is recycled for WTP washdown and foam control in the reactor basins and clarifiers. The process water re-use is estimated to be approximately 40,000 gallons per day (gpd), based on values recorded over several years. (The meter used to record the values has since been taken out of service.) The estimated volume of the return water is subtracted from the plant's daily flow on the Daily Monitoring Record (DMR).

Since 1973, two modifications to the plant processing units have taken place, including the following:

1. Retrofitting of a Hycor rotating grit removal screening unit to the existing aerated grit chamber inlet channel. This unit was installed to increase solids removal and improve influent quality to the aeration basins.
2. Removal of 1 1/2 feet of steel skirting from the bottom of the ring weir on the north clarifier. This modification was done in an attempt to improve sludge settling efficiency.

Since initial plant operation, thick blankets of foam in the aeration basins and subsequent high suspended solids in the final effluent have been an on-going problem. In 1981, the engineering consultant firm of Environmental Services, Inc. was contracted by the City of Gig Harbor to assess the foaming problem. The study concluded that "The severe foaming problem which the plant experiences is probably caused by the wide fluctuations in organic loading which occur between day and night. There is little that can be done to remedy this problem at the present time." In another study by another consulting firm (Kramer, Chin, and Mayo [KCM], 1981), it was concluded that "foaming is most severe in early morning hours when flows and organic loading are low...excessive foaming can result in solids loss into the plant effluent."

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The plant operators concur with the KCM findings that when "foam depth exceeds the height of the feed channel baffles, it is lost to the clarifier effluent, collecting in the chlorine contact chambers." During a plant inspection on December 1, 1983, a thick, foul-smelling, possibly anaerobic blanket of settled solids was observed in the contact chambers. Operator Bill Ireby stated that the chambers are cleaned frequently and the solids are routed to the digester for disposal. He also commented that both the foaming and loss of solids in the effluent continue to be problems.

SAMPLING DESIGN

Influent and effluent grab and 24-hour composite samples were collected during this survey (Figure 2, Table 3).

Twenty-four-hour composite samples were collected with a Manning automatic composite sampler (WDOE) and a Sirco Vary Sampler (WTP). WDOE samples were composited on a time-proportional basis (250 mL/30 min.), and the WTP sample was composited on a flow-proportional basis. Due to plant design, it was not possible for WDOE samples to be flow-composited; therefore, WDOE and WTP compositor samples results are not strictly comparable. The WTP influent compositor was not working at the time of the inspection; therefore, influent split samples were obtained only from the WDOE compositor.

Immediately following the 24-hour composite period, samples were mixed well and split for later analysis by the two laboratories (Table 2). Samples for WTP analysis were refrigerated, and WDOE samples were iced during collection, then stored on ice while being transported to the WDOE Environmental Laboratory in Tumwater WA. Analysis of fecal coliform (FC) bacteria commenced the morning following collection for uniformity of holding time (24 hours).

Discharge line travel times were estimated for later use in selecting an elapsed time for dechlorination of bacterial samples. Since the effluent line acts as an extension of the chlorine contact chamber, a time-adjusted, dechlorinated effluent sample is necessary. Analysis of this sample results in a value which is most closely comparable to the permitted limit.

RESULTS AND DISCUSSION

Conventional parameter results are shown in Table 4. Results of the digester sludge metals analyses are found on Table 5. Table 6 lists all of the analytical results for those parameters associated with NPDES permit compliance. A summary of WTP compliance with permit limits is included in the following:

1. pH values measured during the survey from grab and 24-hour composites fell within the permitted range of 6.0 to 9.0 standard units (SU) for weekly and monthly averages.

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2. Effluent biochemical oxygen demand (BOD) concentration (mg/L) and loading (lbs/day) were within the weekly and monthly average limits using the WDOE 24-hour composite results. The analytical results from the WTP composite effluent sample exceeded both weekly and monthly limits.
3. Effluent suspended solids (SS) concentration (mg/L) and loading (lbs/day) exceeded the weekly and monthly average permit limitations for the WDOE 24-hour composite.
4. Effluent fecal coliform (FC) concentrations (mg/L) were within the weekly and monthly average permit limitations.

Plant design was based on criteria which include a 1980 population projection of 3,500 and an average design flow of 0.45 MGD. At the projected population or organic loading equivalent, the facility would be treating 700 pounds of BOD/day. Present population served is 3,000, with an average flow of 0.28 MGD (July, 1980 DMR).

Table 4 summarizes the results of conventional WDOE analyses for the Gig Harbor Class II inspection. The following is a discussion of these results.

The BOD analysis indicates a substantial reduction of BOD concentrations (mg/L) during treatment. Reduction from 300 mg/L to 19 mg/L in WDOE composites indicates a 93 percent reduction of BOD, reducing total pounds/day from 716 in the influent to 45 discharged to Gig Harbor. Effluent BOD for the Gig Harbor 24-hour composite indicates a much larger discharge to the harbor that exceeds the weekly and monthly NPDES permit requirements (Table 6). The effluent BOD concentration in the WTP composite was 54 mg/L or 129 lbs/day according to WDOE laboratory results. A possible explanation for the discrepancy between the WDOE analysis and the two composites is that the WDOE sample was time-composited (250 mL/30 min.), and the WTP sample was flow-composited. Due to the wide variation in plant flow and organic loading between day and night, the different sampling techniques would collect substantially different sample volumes at different times. It should be pointed out that the Gig Harbor laboratory results for the WTP effluent composite were much lower, 22 mg/L or 62.5 lbs/day (Table 9). This value compares well with the WDOE effluent composite result of 19 mg/L. This may indicate that the higher value discussed above is in error, and that the actual value is nearer 19 to 22 than 54 mg/L. Further comparison of laboratory results is found later in the report, and included on Table 9.

The WDOE influent composite (time-composited) indicates an incoming BOD load of 716 lbs/day during the survey which exceeds the WTP average design loading criteria of 700 lbs/day.

Total suspended solids (TSS) was reduced by 39 percent during treatment, as indicated by the WDOE composites. As previously mentioned, the concentrations and loading of effluent solids exceeded the NPDES permit requirements, thus suspended solids reduction was poor.

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Total residual chlorine (TRC) levels were higher than those necessary for the purposes of disinfection. The NPDES permit requirement for FC is 200 colonies/100 mL of effluent. WDOE results indicate FC concentrations were much lower than required, ranging between 3 and 24 colonies/100 mL. It appears that chlorine dosage could be reduced. Chlorine concentrations in excess of that necessary to achieve permit limits should be avoided.

Wastewater turbidity was reduced by 85 percent during treatment.

Table 5 refers to parameters used for analyzing aeration basin mixed liquor and aerobic digester sludge. The mixed liquor pH and conductivity values were similar to values found in other parts of the WTP process. The mixed liquor suspended solids concentration was within the WDOE criteria (1978), and is discussed in detail later and referred to on Table 7. Aerobic digester sludge metals concentrations were similar to those found in another domestic waste-oriented WTP in the region (Western Slopes WTP, Tacoma WA), and lower than at a plant that handles a large number of industrial customers (Tacoma Central, Tacoma WA).

A major concern regarding the treatment plant is whether or not, and to what extent, the plant is now exceeding its design capacity for organic loading. Although several lines of evidence led to the conclusion that the plant is organically overloaded, the issue is complicated by several factors. It is not clear, for instance, to what extent retrofitting the plant with the influent solids screen has modified the original design calculations. The efficiency of this screen is not well-defined. The data generated during this inspection provide only a single determination of the ability of this unit to decrease organic loading to the aeration basins. All DMR data are based on pre-screen loading to the plant. It should be pointed out that it is very unusual for a conventional activated sludge plant to be designed without a primary clarifier, and that the efficiency of primary clarifiers in reducing organic and solids loading to aeration basins is generally substantially better than the efficiency of rotating screens. The following discussion makes the conservative assumption that design loading is unaffected by the screening unit.

Table 7 lists various plant loading parameters based upon plant design criteria, July 1983 monthly averages, Class II inspection results, and WDOE Criteria for Sewage Works Design (1978). As displayed on Table 7, the July DMR and Class II results indicate that the facility is receiving organic loading (BOD lbs/day) in excess of the original design criteria. These results suggest that the population served as listed on the DMRs may not be accurate. Figure 5 is a graph representing four years and two months of monthly average data for influent BOD loading (lbs/day), influent BOD strength (mg/L), influent SS loading (lbs/day), and effluent SS (lbs/day). Figure 6 represents monthly average flows and peak flows (both MGD) for the same period. From the graphs it is apparent that the organic loading to the WTP has continued to increase over the past several years and is now at or above the designed loading. At the same time, influent BOD strength has remained relatively constant (Figure 5). Effluent SS has also increased to a level that exceeds the plant's NPDES

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permit discharge limitation. Influent SS loading indicates a marked increase to the plant, in particular during the period from July 1981 to August 1983. Plant flow over the entire period has demonstrated a steady increase, although it is still below the plant's design flow (Figure 6). All of these factors suggest that the facility may be approaching treatment capacity for organic loading while still below design capacity for flow, indicating that design changes (i.e., increased treatment capacity) may be necessary for adequate treatment. In a memo to the mayor of Gig Harbor, KCM (1980) state that "the organic loading was based on a population of 3500 persons...the design waste was therefore 186 mg/L BOD. Since current waste concentrations average 250 to 300 mg/L, it appears that actual per capita organic loading rates are higher than were anticipated during design. This could be due to a higher-than-normal restaurant and commercial loading in Gig Harbor. This would explain the apparent fact that the treatment facility is approaching its design limit for organic loading more rapidly than its limit based on hydraulic capacity."

Figure 5 indicates that the BOD influent strength has remained relatively constant at approximately 300 mg/L while flows have increased (Figure 6). The constant concentration and increasing flows suggest that new hookups rather than increased loading per capita is the source of the increase in organic loading. A report from KCM (1980) states that "data from current operation indicate a current annual rate of increase of approximately 100 lb/COD/Day/Year (approx. 75 lb BOD/Day/Year). At this rate of increase, the recommended maximum plant capacity would be reached in approximately 3 years." This places 1983 as the year maximum capacity was to be reached, which is supported by the findings on Figures 5 and 6 and Table 7. Figure 5 indicates that influent BOD over the past year (January 1982 to January 1983) has almost consistently been above the design criteria for loading (700 lbs. BOD/Day).

Figure 5 influent SS (lbs/day) indicates a substantial loading increase that parallels the rise in BOD loading. Another indicator of the high organic solids BOD loading is the substantial BOD removal by the rotating grit screen (Table 4). Twenty-four-hour composite samples were collected upstream and downstream from the screening unit. Although this represents only a single set of data points, the downstream sample BOD demonstrated a decrease in concentration (300 versus 240 mg/L). Therefore, it is possible that the screen's ability to remove BOD as solids may have partially offset the impact of increasing organic loads. During the inspection, 28 percent of the incoming BOD was removed by the screening action which resulted in a reduction of about 200 lbs. of BOD/day.

The performance of the activated sludge system during the Class II inspection is compared to other activated sludge criteria in Table 7. The system was meeting all requirements as determined by WDOE Criteria for Sewage Works Design with the exception of the food-to-microorganism ratio (f:m). The ratio was slightly lower than the criteria, which indicates that biomass concentrations may be somewhat higher than necessary. To increase the f:m ratio, more sludge would need to be wasted from the system. In contrast to the low

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f:m ratio, sludge age or mean cell residence time (mcrt) was bordering on the lower end of the scale--6.5 days (criteria = 5 to 15 days). This indicates that if sludge age is reduced it should be by only a small amount. Both parameters suggest that sludge wasting could be increased slightly, resulting in improved operation.

The mixed liquor suspended solids (MLSS) concentration was within the WDOE criteria; however, in order to improve the f:m ratio the concentration would have to be reduced. MLSS concentrations would tend to decrease if the sludge wasting schedule was changed, as suggested. Previous assessments of the foaming and solids loss problems have recommended altering sludge age and MLSS concentrations (KCM, 1980), and focused on potential inadequacies in secondary clarifier design (KCM, 1980; ES, 1981). However, as previously mentioned, other factors may contribute to the high effluent SS and poor settling characteristics, including foaming in the aeration basin. The foaming may be a result of excessive organic loading and/or shock loading to microorganisms in the aeration basins. These conditions could be brought about by wide variations in flow and organic loading (Figure 4). The flow variations are a result of pump station surging and diurnal changes in sewage volume, as demonstrated by the WTP script chart (Figure 4). Foaming and bulking occur regularly at the Gig Harbor WTP. A phenomenon that commonly occurs under these conditions (variable flows and loads) is the growth of filamentous bacteria. The bacteria incorporate solids and air bubbles from aeration in a matrix (foam) that is difficult to break down (Ludwig, 1981). It is noteworthy that Jim Landon (plant supervisor) has looked for and has not observed filamentous bacterial growth. This may indicate that other factors besides correcting flow and loading might be needed before the problem is resolved.

On December 1, 1983, a followup investigation of the Gig Harbor WTP was conducted with the specific purpose of determining the oxygen content in the aeration basins and the secondary clarifiers. A portable IBC oxygen meter was used. The probe was lowered into the treatment units. Oxygen concentrations and temperature were measured every three feet (Table 8). Results suggest that oxygen levels in the treatment units were sufficient to maintain aerobic conditions. The WDOE Criteria for Sewage Works Design suggests a minimum of 2.0 mg/L of oxygen at average design load and 0.5 mg/L at peak design load for an activated sludge treatment process. All of the process units measured displayed values above this minimum.

Table 7 lists several design criteria for the secondary clarifiers. The clarifiers meet the WDOE design criteria for the design flow of 0.45 MGD and for the following: surface loading rate, solids loading rate, and hydraulic loading rate (WDOE, 1978). The criteria are based on total surface area of the clarifiers. The clarifiers also meet most of the criteria based on the smaller effective surface area (inside the rim feed weir) with the exception of the hydraulic loading rate. It should be noted that at the smaller effective surface area (22-foot diameter), the hydraulic capacity is 0.1 MGD greater than the flows presently experienced at the WTP (0.38 MGD versus 0.28 MGD).

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LABORATORY PROCEDURE REVIEW

On July 19, 1983, a laboratory procedure review was conducted at the Gig Harbor WTP. Present during the review were Jim Landon (plant supervisor) and Bill Yake and Dale Clark (WDOE water quality investigators).

The laboratory procedure review consisted of four main elements, including the following: (1) Split Sample Results, (2) Sample Collection and Recommendations, (3) BOD Procedures and Recommendations, and (4) TSS Procedures and Recommendations. The original Laboratory Procedural Survey is included in this report following Table 9.

1. Split Sample Results

Twenty-four-hour composites were split with the operator in order to compare laboratory analytical results. The comparisons are found on Table 9. The analysis included BOD (mg/L), TSS (mg/L), and TRC (mg/L)

BOD results indicate poor comparison between laboratories, with the exception of the WDOE effluent composite sample. When compared to the WDOE analysis for both the WDOE influent and WTP effluent, the WTP analytical results are lower.

TSS results indicate good comparison, with the exception of the Gig Harbor analysis of the WDOE effluent composite. The Gig Harbor analysis of the WDOE effluent composite is substantially lower (18 mg/L versus 98 mg/L). A possible explanation for this disparity is that the WDOE composite sample was not adequately mixed by the WTP laboratory prior to analysis.

Residual chlorine concentrations for individual grabs suggest a poor comparison of in-field versus laboratory analysis. Analytical results varied by as much as 1 mg/L. WDOE used an in-field DPD chlorine analyzing kit, and the WTP used a Hach colorimeter chlorine meter.

2. Sample Collection and Recommendations

The Gig Harbor WTP composite samples are collected by a Sirco Automatic Sampler. Influent samples were not being collected at the time of the survey due to changes in screening procedures and new construction which made the sampler inoperable. Final chlorinated effluent samples were collected via a feed line to the chlorine contact chamber. Samples are composited on a flow-proportional basis. In order to determine the WTP's ability to remove BOD and TSS, it is essential to quantify the influent concentration; therefore, it is recommended that the influent composite sampler be returned to service as soon as possible.

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Results from WDOE nutrient analysis indicate that nitrification may be occurring in the WTP effluent sampling line (Table 4). Evidence for this includes the increase in nitrate and nitrite concentrations and the reduction in ammonia when the influent and effluent WDOE sample results are compared to effluent WTP composite sample results. The disparity between sample results indicates nitrate and nitrite concentrations observed in the WTP effluent sampler were probably not a result of process nitrification, but due to sampling procedure. It is recommended that the sampling lines be cleaned on a more frequent basis and a stronger solution of chlorine be used to destroy any troublesome bacterial growth.

3. BOD Procedures and Recommendations

The Gig Harbor WTP uses the WDOE BOD laboratory procedure. Dilution water is prepared by adding pre-mixed "pillows" of (4) nutrient buffers (1 per each 6 liters) within 18 hours of the test. Phosphate buffer is added four to five hours prior to testing. The dilution water is maintained in darkness at room temperature (approximately 20°C).

At present, the BOD test is conducted on a weekly basis. Prior to a recent request by the SWRO (Monahan, 1983), chemical oxygen demands (CODs) were being run in lieu of the BOD test. Samples are held a maximum of 24 hours prior to testing. Effluent samples are dechlorinated using potassium iodate titrant to determine the amount of sodium thiosulfate needed. Following dechlorination, test samples are re-seeded using the influent supernatant. The seed material is added to the BOD bottle just prior to testing.

The 5-day dissolved oxygen (D.O.) depletion for the blank is determined, and normally falls within a range of 0.1 to 0.2 mg/L. Occasionally, however, it may be more. The normal range of initial (zero-day) D.O. is between 6.8 and 8.5 mg/L. Initial D.O. concentrations should be near saturation which is 9.2 mg/L at 20°C and air pressure at sea level. In order to achieve saturation, it may be necessary to use aeration. Filtration of the aeration air pump, and a cotton plug inserted in the mouth of the storage vessel are recommended to avoid contamination (i.e., airborne dirt, bacteria, etc.) of the dilution water.

pH of BOD samples is checked to ensure it falls in the range of 6.5 to 8.5. If it falls out of this range, the samples are adjusted to this range using ammonium hydroxide or sulphuric acid. pH is measured using a Corning pH meter. The meter is calibrated on a daily basis using buffers of 4 and 7. At the time of the inspection, the pH meter did not appear to be functioning properly even though it was calibrating. The pH values were approximately 1 pH unit above those recorded by the WDOE meter.

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Some problems with temperature regulation in the incubator have occurred such that only the top shelf of the incubator can be used. The incubator temperature gage is checked on an irregular basis for accuracy, and no log of temperatures is maintained. This procedure should be corrected.

BOD dissolved oxygen analyses are determined using a YSI (Model #54) oxygen meter. The meter is calibrated against D.O.s analyzed by the Winkler titration method. Calibration occurs on a monthly basis. PAO is used as the titrant and is not standardized; instead, pre-mixed packets are used for the test. The PAO should be standardized using the method found in Standard Methods (15th ed.), or regularly checked for normality.

Recommendations:

1. Repair or replace the pH meter or probe so that pH of the BOD samples can be accurately determined.
2. Check the temperature of the water bath more often to ensure correct incubator temperature ($2^{\circ}\text{C} \pm 1^{\circ}\text{C}$), and record in a temperature log book.
3. Calibrate the D.O. meter every time it is used. Titrant (PAO) normality should be determined, and D.O. calculations modified accordingly.
4. To ensure an adequate D.O. for the zero-day D.O. depletion, aeration should be used in the dilution water during storage to maintain a saturated D.O. of approximately 9.2 mg/L.

4. Total Suspended Solids Procedures and Recommendations

TSS is determined using Standard Methods (15th ed.). The samples are filtered through Whatman filter papers (934 AH) using a Buchner funnel. The filter papers are prewashed and dried for one hour in an oven at 103 to 105°C. Following drying, the filter papers are cooled in a desiccator prior to weighing. The papers are stored in the desiccator until needed. Following sample filtration, the filters are dried for one hour and allowed to cool in a desiccator prior to weighing and reweighing. The filters are not redried prior to the reweighing procedure.

Recommendations:

Repeat drying and cooling cycle prior to reweighing until a constant filter weight is obtained or until the weight loss is less than 0.5 mg.

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CONCLUSIONS AND RECOMMENDATIONS

The Gig Harbor WTP appears to be approaching capacity. The facility has consistently exceeded NPDES permit requirements for TSS discharge limitations over the past year, and is receiving influent BOD loadings in excess of plant design criteria (Figure 5). Further population and business expansion in the area may be limited by the treatment plant's inability to handle the wastes generated.

The facility appears to be well-run, with minimal room for improvements in operation which will substantially improve effluent quality. Future increases in capacity will probably require physical modifications for improving the handling of incoming wastewater and/or increasing plant process capacity.

Installation of an influent holding tank has been recommended by Jim Landon (WTP supervisor) and Gary Tannahill (city engineer). This tank would allow equalization of the diel flow cycle (high flow - day; low flow - night) to be somewhat dampened and allow for a more constant organic loading to the plant's biomass.

A second possibility is installation of a primary clarifier to decrease BOD and SS loading to the aeration basins. Design of a conventional activated sludge plant without primary clarification is very unusual. Although screening does provide some BOD and SS removal, a clarifier would be more efficient and would provide a small amount of equalization.

Either of these modifications would have to be assessed carefully prior to implementation. Probably either would improve effluent quality at the Gig Harbor WTP. However, it appears that increasing loading to the plant would be unwise until the efficiency of any modifications is fully ascertained.

DC:cp

Attachments (tables, figures)

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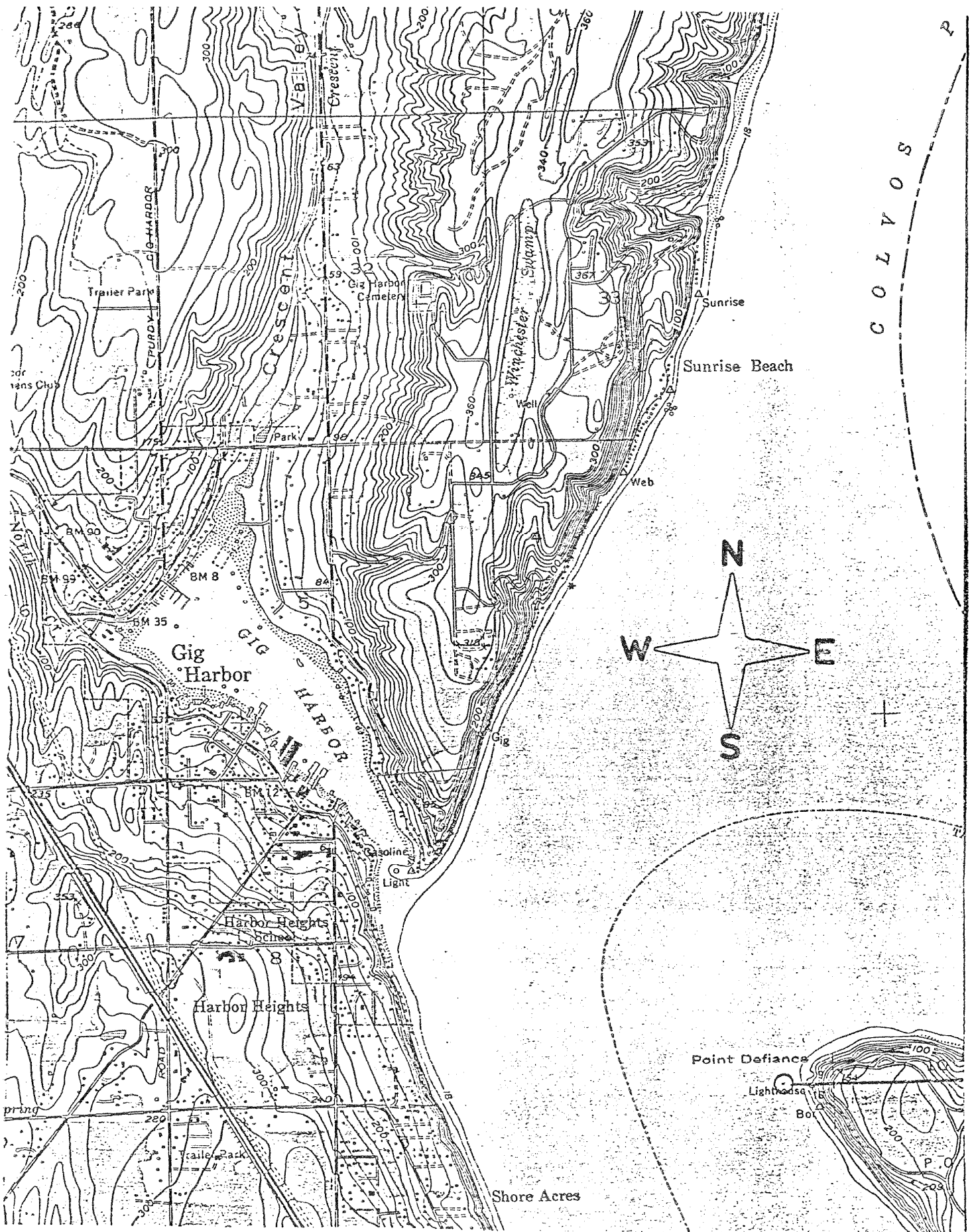
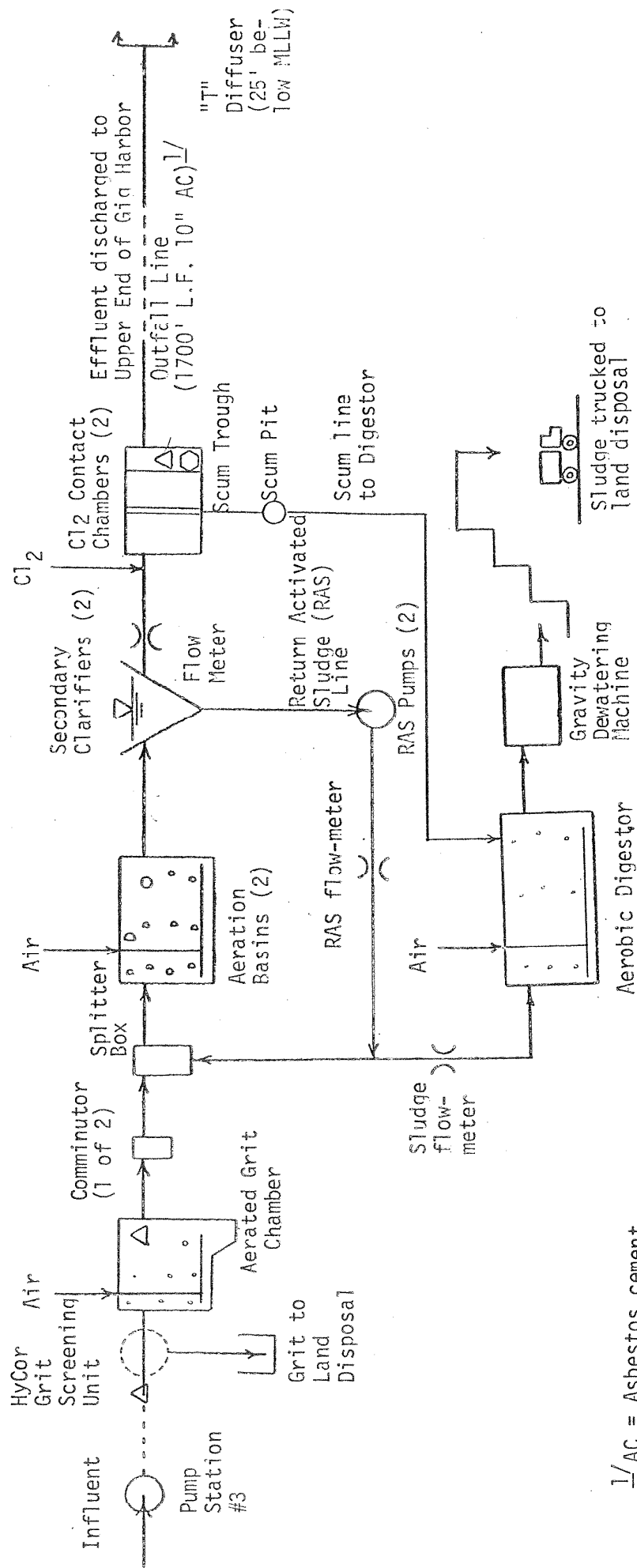


Figure 1. Map showing location of Gig Harbor in relation to Puget Sound at Calvos Passage.
Scale: 4.2 cm = 1 km

Figure 2. Gig Harbor wastewater treatment plant flow scheme for July 18 and 19, WDOE Class II inspection.
[flow diagram from Kramer, Chin and Mayo, October 1980]

△ WDOE influent and effluent composite sampler locations.
○ Gig Harbor effluent composite sampler location.



1" AC = Asbestos cement.

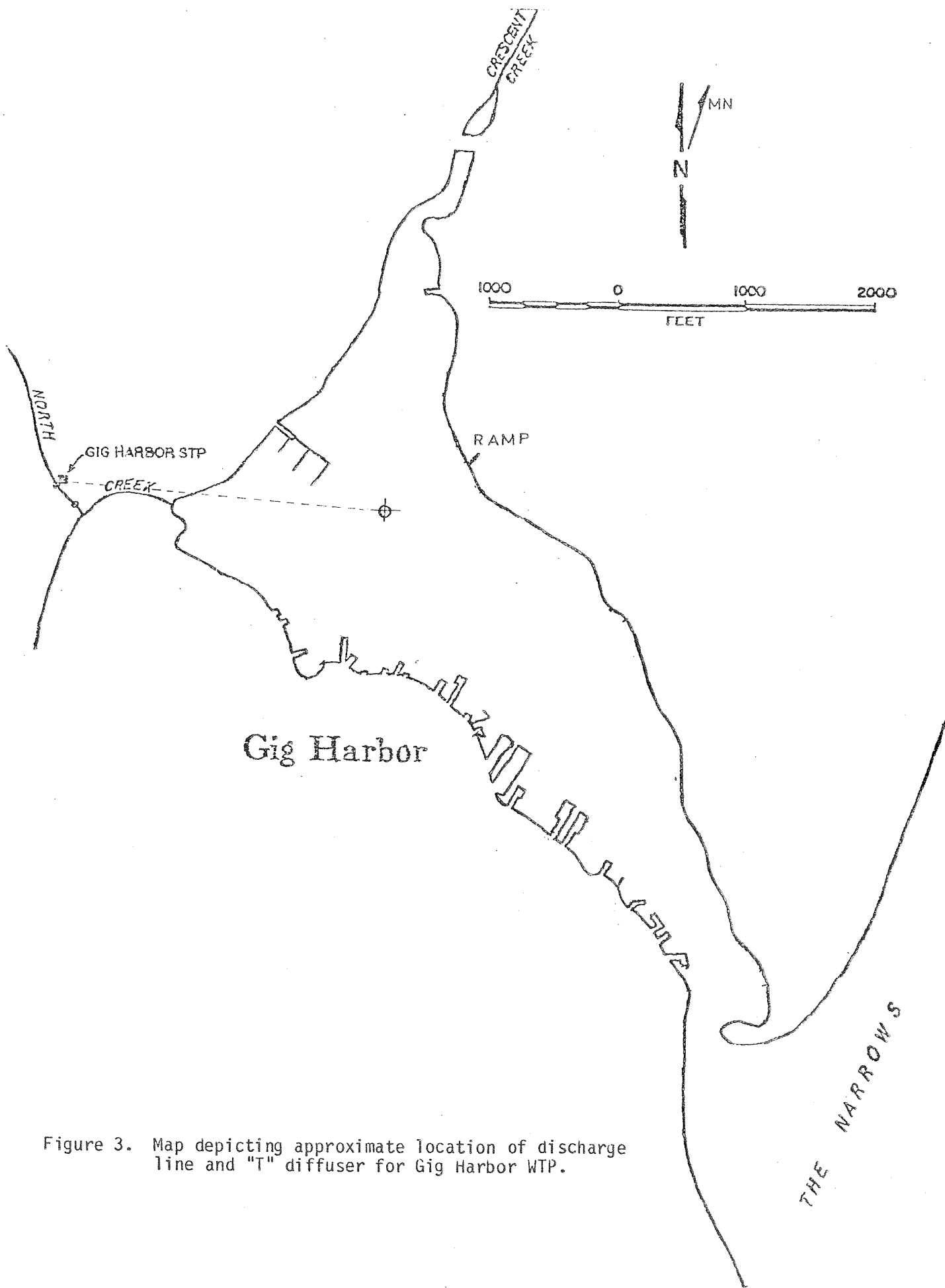


Figure 3. Map depicting approximate location of discharge line and "T" diffuser for Gig Harbor WTP.

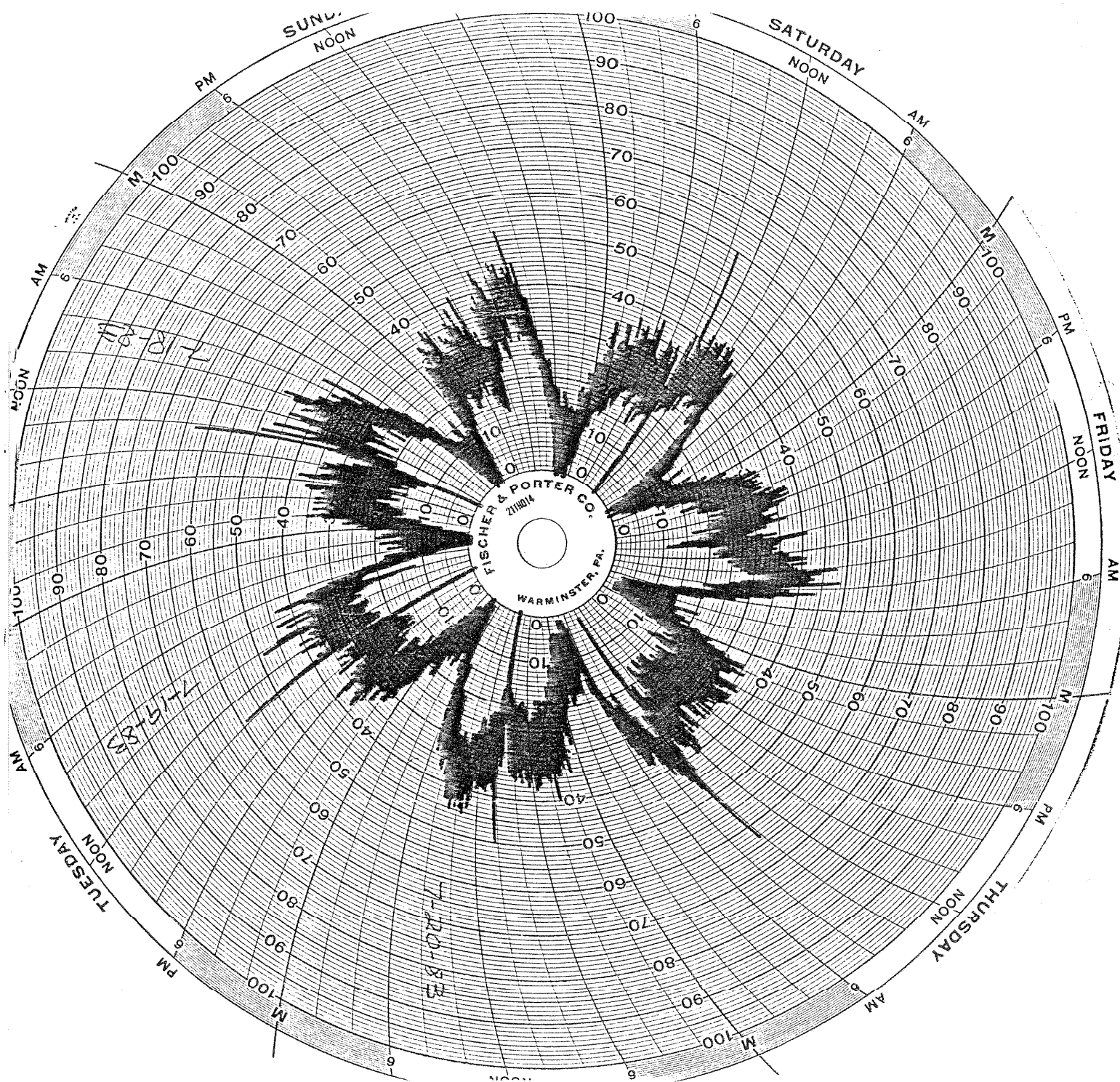


Figure 4. Script chart of the Gig Harbor WTP plant flow for July 18-20, 1983.

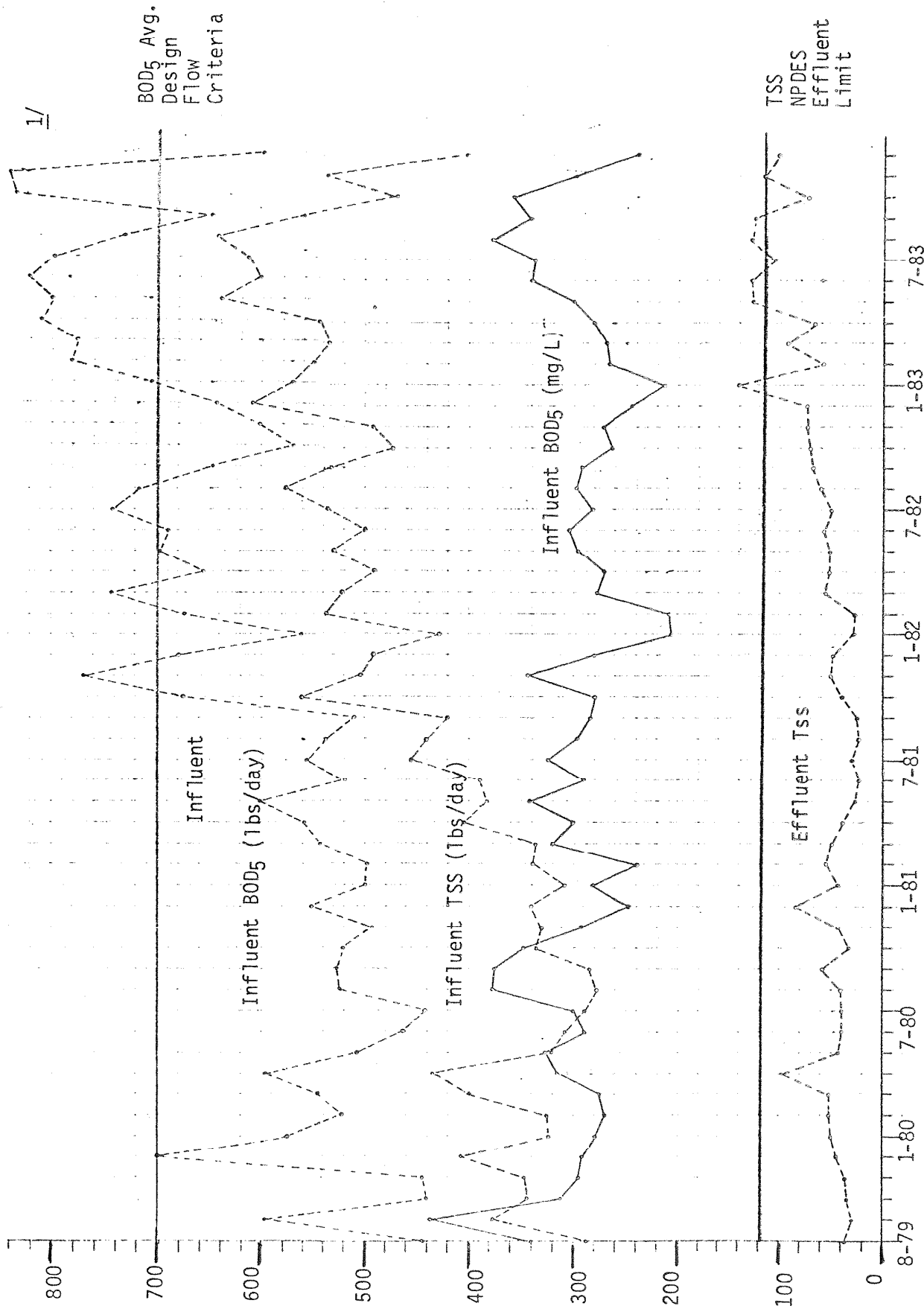


Figure 5. Gig Harbor WTP TSS and BOD₅ influent loading curves and TSS effluent curve demonstrating upward trend in organic loading from 8/79 to 12/83. Note that influent BOD₅ strength (mg/L) has remained relatively constant (from WTP Daily Monitoring Report monthly average).

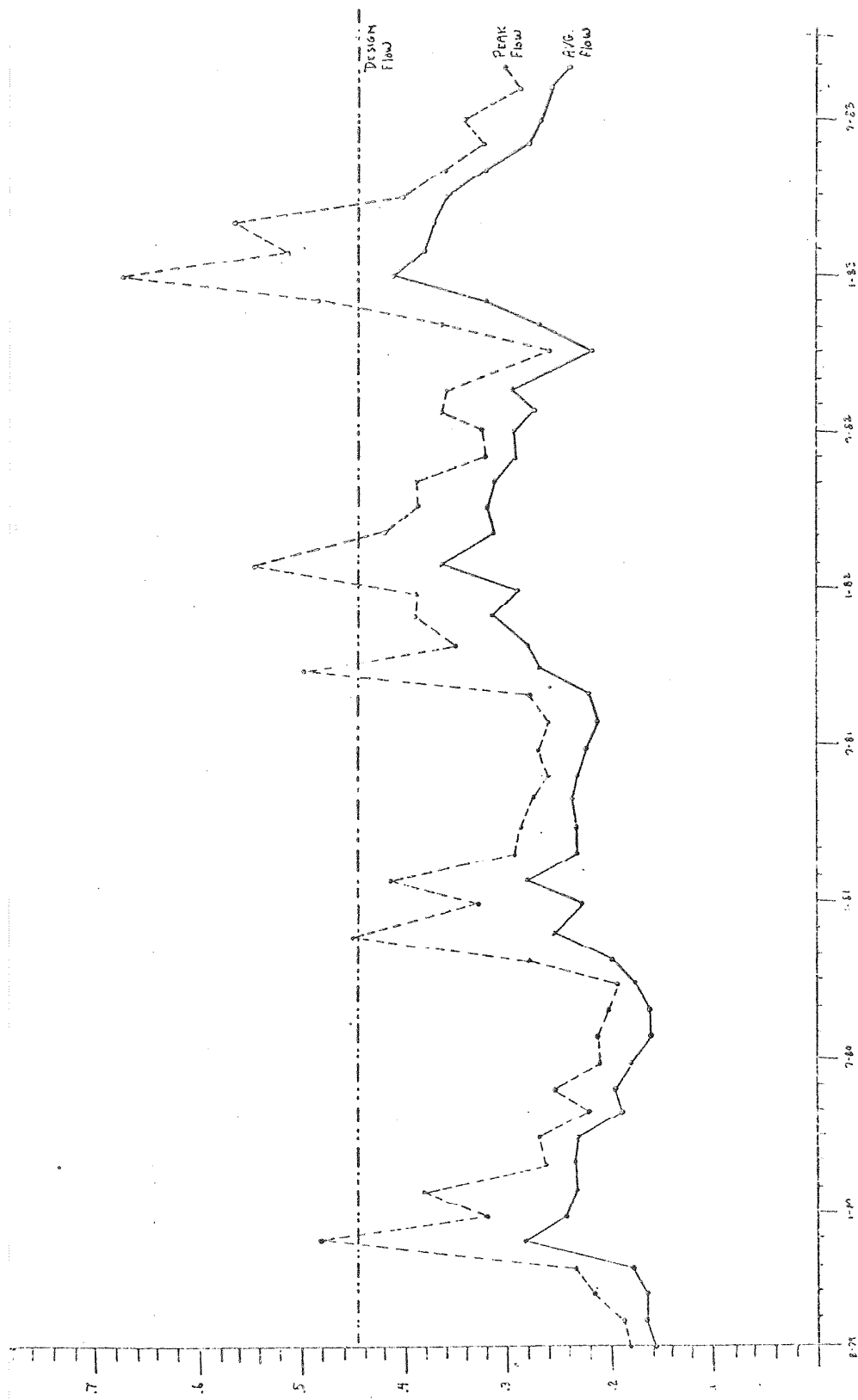


Figure 6. Line graph illustrating monthly average flows from August 1979 to November 1983
Daily Monitoring Reports (DMRs) for daily average flow and peak flow.

Table 1. Gig Harbor wastewater treatment plant existing facilities as of the July 18-19, 1983 WDOE Class II inspection. Unit dimensions from Kramer, Chin and Mayo, 1980. (refer to Figure 2)

Unit	Size/Capacity
Influent pumps (station #3)	3 pumps at 850 GPM each, pumping capacity for 2 = 2.2 MGD
HyCor rotating grit removal screen	30,000 mesh - retrofitted to aerated grit chamber ¹
Aeration chamber (previously for grit)	7,500 gallons, 10' x 10' x 10' (SWD) ² , 75 SCFM air (maximum)
Aeration basins - complete mix	2 at 18' x 18' x 16' (SWD), total volume = .079 mg, bubble diffusers at 12' depth
Secondary clarifiers - rim feed/center effluent	2 at 25' diameter x 10'3" SWD, surface area = 980 ft ² Note: effective dia. = 22', surface area = 760 ft ²
Plant flow meter	Propeller meter 160 - 1000 GPM, circular script chart recorder
Chlorine contact chamber	2 at 7' x 24' x 7.5' (SWD), total volume = .019 mg
Outfall line/T diffuser	1700 linear feet, 10" asbestos cement pipe with T-diffuser located at 25' (MLLW) in Gig Harbor basin

¹Information obtained from WTP operator (Landon, 1983).

²SWD = Side wall depth.

Table 2. Analyses and laboratories associated with WDOE Gig Harbor Class II survey for July 18-19, 1983 (all mg/L unless noted).

<u>Analyses</u>	<u>Laboratory Performing Analyses</u>
Oil and grease, pH (units), turbidity (NTU), specific conductivity (umhos/cm), COD, BOD (5-day), BOD (inhibited), nutrients (NO ₃ -N, NO ₂ -N, NH ₃ -N, O-PO ₄ -P, Total-P), solids (total, total non-volatile, total suspended, total non-volatile suspended), alkalinity (CaCO ₃), salinity (ppt at 22.5°C), fecal coliform (col/100 mL), sludge metals (Cu, Zn, Ni, Cr, Cd, Pb, all total), sludge dry solids (mg/Kg)	WDOE Environmental Laboratory, Tumwater, Washington
BOD (5-day), suspended solids	Gig Harbor WTP Laboratory, Gig Harbor, Washington

Table 3. Sample times and locations for WDOE July 19, 1983 Gig Harbor Class II survey.

24-hour Composite Samples				
Sample	Sampler	Installation Date (time in - time out)		Location
Influent-1	WDOE	7/19/83	1034 - 0934	In channel upstream from rotating grit remover screens
Influent-2	WDOE	7/19/83	1040 - 0933	In grit chamber downstream from rotating grit reemover screens
Chlorinated Effluent	WDOE	7/19/83	1119 - 0933	Collection trough following chlorination and prior to entering discharge line
Effluent	Gig Hbr.	7/19/83	0700 - 0700	Same as above

GRAB Samples				
Sample	Collection date (time)		Laboratory Analysis	
Influent	7/19/83 (1042)			
	(1358)			
	7/20/83 (1012)			
	(1140)			
Effluent	7/19/83 (1300)		Fecal coliform	
	(1326)		Fecal coliform	
	7/20/83 (1049)		Fecal coliform	
Mixed Liquor	7/19/83 (1110)		Dissolved oxygen	
	7/20/83 (1032)		Dissolved oxygen	
	7/20/83 (1135)		Total suspended solids, total non-volatile suspended solids, oil and grease, dissolved oxygen	
Sludge	7/20/83 (1030)		Metals (Cu, Zn, Ni, Cr, Cd, Pb), percent solids	

Field Analysis				
Location	Sample Date (time)		Field Analysis	
Influent	7/19/83 (1042)		pH, temperature, conductivity	
	7/19/83 (1358)		pH, temperature, conductivity	
	7/20/83 (1012)		pH, temperature, conductivity	
	7/20/83 (1140)		pH, temperature, conductivity	
Mixed Liquor	7/19/83 (1110)		pH, conductivity	
Effluent	7/19/83 (1119)		pH, temperature, conductivity, total chlorine residual	
	7/19/83 (1402)		pH, temperature, conductivity	
	7/20/83 (1015)		pH, temperature, conductivity, total chlorine residual	
	7/20/83 (1145)		pH, temperature, conductivity, total chlorine residual	

Table 4. Gig Harbor WTP, conventional pollutant results, July 18-19, 1983. All results in mg/L except where noted.

Parameter	Influent WDOE Sample Before Screen	Influent WDOE Sample After Screen	Chlorinated Effluent WDOE Sample	Chlorinated Effluent WTP Sample
Flow (MGD)	.29	.29	.29	.29
BOD ₅ (mg/L)	300	240	19	54
(lbs/day)	716	513	45	129
Cond. (umhos/cm)	574, 430†, 580††, 500††, 590††, 480††	600, 550†	535, 560†, 480††, 441††, 415††, 480††	590, 510†
pH (S.U.)	7.3, 7.6†, 7.7††, 7.4††, 7.4††, 7.1††	7.2, 7.4†	7.1, 7.1†, 6.8††, 6.9††, 6.9††, 6.7††	7.4, 7.3†
Temp. (°C)	19.0††, 20.0††, 20.0††, 20.2††		20.6††, 20.5††, 20.2††, 20.3††	
T. Chlor. Resid.			2.5††, 2.5††, 2.5††	1.8††, 1.7††, 1.5††
Fecal Coliform (col/100 mL)			24 at 26 min††† 3 est. at 23 min	
Turbidity (NTU)	120	130	18	38
Total Solids	500	470	320	360
TSS (mg/L)	160	160	98	63
(lbs/day)	382	382	234	150
TNVS	220	220	180	240
TWSS	12	18	1	12
NH ₃ -N	23	23	14	12
NO ₂ -N	<.10	<.10	<.05	.60
NO ₃ -N	<.10	<.10	.25	1.40
O-P04-P	5.4	5.8	5.4	6.0
T-P04-P	7.6	8.2	5.3	6.2
COD	460	410	67	91
Alkalinity	180	180	140	120
Chloride	0.3	0.3	0.3	0.3
Chlorine			2.5††, 2.5††, 2.5††	

† = In-field analysis of composite samples.

†† = In-field analysis of grab samples.

††† = Detection time prior to dechlorination to simulate outfall line retention time prior to effluent discharge.

Table 6. Permit compliance, Gig Harbor WTP, July 18-19, 1983 Class II inspection.

Parameter	Final (chlorinated) Effluent Values 7/20/83	Permit Requirements	
		Weekly Average	Monthly Average
Flow (MGD)	.29	.45	.45
BOD (mg/L)	19	45	30
(lbs/day)	45.4	169	113
Suspended Solids (mg/L)	98	45	30
(lbs/day)	234	169	113
pH (S.U.)	7.1, 6.8†, 6.7†, 6.1, 6.9†, 7.3, 6.9†	6.0-9.0	6.0-9.0
Fecal Coliform	26 (24)††, 18 (3)††	400	200

†Grab sample, field analysis.

††FC samples held for a period equivalent to the discharge line time of travel prior to dechlorination.

Table 7. Comparison of plant loading parameters from original design criteria, July 1983 Daily Monitoring Report (DMR) monthly averages, Class II inspection July 18-19, 1983, and available WDOE Criteria for Sewage Works Design (1978). Gig Harbor WTP.

Parameter	Design Criteria ¹	DMR (influent before screening) ²	Class II (after screening) ²	WDOE Criteria
Population equivalents ³	3,500	4,000	3,580	2,565
Average flow (Q)	.45	.28	.29	.29
Peak flow (3Q)	1.4			100 gals/day/person
BOD ₅ (mg/L)	187	342	296	240
(lbs/day)	700	799	716	513
<u>Aeration Basins</u>				
Volumetric loading (lbs BOD/1000 ft ³ /day)	68	77	695	49
Detention time (hours)	4.2	6.8	6.5	20-120
F:M ratio (food-to-microorganism)	.07	.18	.16	3-5
Sludge Wasting schedule (lbs/day)	450-550	400	400	.2-.6
Mixed liquor suspended solids (mg/L)	6,000-10,000	3,400	3,200	2,000-5,000
MCRT (mean cell residence time)	20.8	8.6	6.5	5-15

Parameter	Design Criteria	DMR	Class II	WDOE Criteria Average Design Flow Peak
<u>Secondary Clarifiers</u>				
Surface overflow rate (gpd/ft ²)	453	285	295	400-600
2 at 25' (total diameter)	591	368	381	400-600
2 at 22' (effective diameter)				
Solids loading rate (lb[mass]/day ft ²)	25	8.1	7.9	25
at 980 ft ² (total area)	25	10.5	10.2	25
at 760 ft ² (effective area)				
Hydraulic loading rate (MGD) ⁴	Average = .49	.28	.29	.39-.59
980 ft ² (total area)	Average = .38	.28	.29	.30-.46
760 ft ² (effective area)				
<u>Chlorine Contact Chamber</u>				
Detention time (hours) ⁴	1 hour	1.6	1.6	1
design flow	.33			
peak flow				.33

- ¹Design criteria from Kramer, Chin and Mayo (1980).
²Screening = solids removal from HyCor rotating grit removal screen.
³Population equivalents = influent BOD (lbs/day)/(.2 lb BOD/day/person).
⁴Hydraulic loading rate based on clarifier area x surface overflow rate.
⁵Contact chamber volume = 19,000 gal.

Table 8. WDOE Gig Harbor WTP in-field dissolved oxygen (D.O.) survey for return activated sludge reactions and secondary clarifiers (December 1, 1983). D.O. concentrations (mg/L) were determined using an IBC oxygen meter.

Station	Time	Depth (feet)	Temp. (°C)	D.O. (mg/L)
North Reactor Basin	1103	0	14.5	5.8
	1109(1155) ¹	3	15.0(15.5) ¹	5.4(5.3) ¹
	1110(1156)	6	15.0(15.5)	5.0(5.0)
	1111(1157)	9	15.0(15.5)	4.7(4.3)
	1112(1158)	12	15.5(15.5)	4.5(4.0)
	1113(1159)	15	15.5(15.5)	4.2(3.9)
	1114(1200)	17	15.0(15.5)	2.7(3.8)
South Reactor Basin	1115	3	15.5	6.5
	1116	6	15.0	6.8
	1117	9	15.0	6.1
	1118	12	15.0	4.7
	1119	15	15.5	4.3
	1120	18	15.5	3.9
North Clarifier	1202	0	14.5	4.8
	1203	3	-- ²	3.9
	1204	6	--	3.3
	1205	9	15.5	2.7
	1206	10	15.5	2.5
South Clarifier	1207	0	14.5	4.8
	1208	6	--	4.3
	1209	9	--	4.3
	1210	12	--	3.8
	1211	15	--	3.5

¹Replicate samples.

²-- = No readings due to meter malfunction.

Table 9. Comparison of WDOE and WTP laboratory and in-field analysis results for the Gig Harbor WTP survey July 18-19, 1983.

Parameter	Sample	Sampler	Laboratory	
			Gig Harbor	WDOE
Biochemical Oxygen Demand (BOD, mg/L)	Influent composite (24-hr)	WDOE	210	300
	Effluent composite (24-hr)	WDOE	13	19
	Effluent composite (24-hr)	Gig Hbr.	22	54
Total Suspended Solids (TSS, mg/L)	Influent composite (24-hr)	WDOE	152	160
	Effluent composite (24-hr)	WDOE	18	98
	Effluent composite (24-hr)	Gig Hbr.	56	63
Residual Chlorine (mg/L)	Chlorinated effluent grab	WDOE	1.8	2.5
	Chlorinated effluent grab	WDOE	1.7	2.5
	Chlorinated effluent grab	Gig Hbr.	1.5	2.5